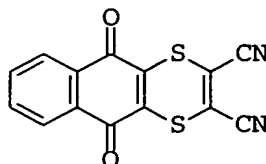


Fungicidal mixtures based on dithianon

The present invention relates to fungicidal mixtures, comprising

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A) the compound of the formula I



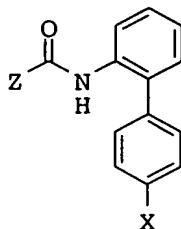
I

10

and

B) a biphenylamide of the formula II,

15



II

20

in which Z is a pyridyl ring or a five-membered heteroaryl ring which, in addition to carbon atoms, contains one or two nitrogen atoms or one nitrogen atom and one oxygen or sulfur atom,

25

where Z carries one to three identical or different substituents from the group consisting of halogen, methyl, and trifluoromethyl, and X is halogen, in a synergistically effective amount.

30

Moreover, the invention relates to methods for controlling harmful fungi using mixtures of the compounds I and II and to the use of the compounds I and II for preparing such mixtures.

35 It is an object of the present invention to provide mixtures which have improved activity against harmful fungi combined with a reduced total amount of active compounds applied (synergistic mixtures), with a view to a desired reduction of the application rates and broadening the activity spectrum of the known  
40 compounds.

We have found that this object is achieved by the mixtures defined at the outset. Moreover, we have found that applying the compounds I and II simultaneously, i.e. together or separately,  
45 or applying the compounds I and II in succession provides better

## 2

control of harmful fungi than is possible with the individual compounds alone.

Usually, mixtures of the compound I with one biphenylamide II are used. However, in certain cases mixtures of the compound I with two or more biphenylamides II may be advantageous.

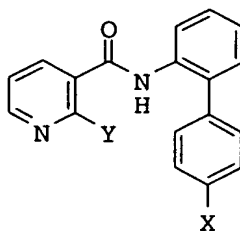
The compound of the formula I (common name: dithianon) and processes for its preparation are described in DE-AS 1 060 655 and GB-A 857 383.

The biphenylamides of the formula II, their preparation and their action against harmful fungi are likewise known from the literature [cf. EP-A 545 099].

15

In the definitions given in formula II, halogen denotes fluorine, chlorine, bromine and iodine, in particular fluorine and chlorine.

20 In a preferred embodiment of the mixtures of the invention, formula II relates in particular to compounds in which Z is a substituted 3-pyridyl ring, and in particular a 3-pyridyl ring which is substituted in the 2-position. These compounds correspond to the formula IIA in which X is halogen and Y is  
25 trifluoromethyl or halogen:



IIA

30

Preference is given to compounds of the formula IIA in which X and Y are identical or different and are halogen, in particular  
35 fluorine or chlorine.

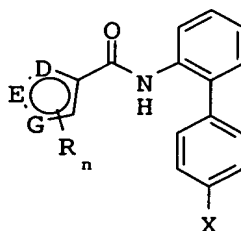
Suitable for the mixtures according to the invention are in particular the following compounds of the formula IIA:

Compound No.	Y	X
II-1	Cl	Cl
II-2	Cl	F
II-3	F	Cl
II-4	F	F
II-5	CF <sub>3</sub>	Cl
II-6	CF <sub>3</sub>	F

## 3

Particular preference is giving to mixtures of dithianon I with the compound II-1 (proposed common name: boscalid).

- In another embodiment of the mixtures according to the invention,  
 5 formula II denotes biphenylamides in which Z is a five-membered heteroaryl ring which, in addition to carbon atoms, contains one or two nitrogen atoms or one nitrogen atom and one oxygen or sulfur atom and which carries one, two or three substituents from the group consisting of halogen, methyl and trifluoromethyl.  
 10 These compounds correspond to the formula IIB in which the variables are as defined below.

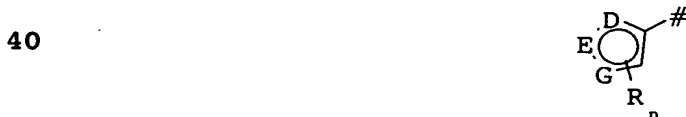


IIB

- 15  
 20 D is carbon or sulfur;  
 E is carbon or nitrogen;  
 G is oxygen, carbon or nitrogen; with the proviso that at least one of the variables D, E and G is not carbon;  
 25 R is halogen, methyl and halomethyl, in particular trifluoromethyl;  
 n is 1, 2 or 3, where the groups R may be different if n is  
 30 greater than 1.

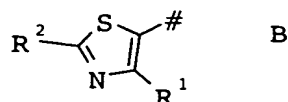
Compounds of the formula IIB, their preparation and their fungicidal activity are known from the literature (cf.:  
 WO-A 01/42223; DE-A 198 40 322; JP-A 07/145 156;  
 35 JP-A 2001/302 605).

Preference is given to compounds of the formula IIB, in which the group,



where # denotes the bond to the carbonyl group, denotes one of the two groups A and B below

45



in which R<sup>1</sup> and R<sup>2</sup> are as defined below:

R<sup>1</sup> is hydrogen, methyl or trifluoromethyl; and

10 R<sup>2</sup> is hydrogen, methyl or halogen.

In addition to the compounds of the formula IIA, the following compounds II are particularly suitable for the mixtures according to the invention:

15

Compound No.	Z	R <sup>1</sup>	R <sup>2</sup>	X
II-7	A	CF <sub>3</sub>	H	Cl
II-8	A	CF <sub>3</sub>	H	F
II-9	A	CH <sub>3</sub>	F	Cl
20 II-10	A	CH <sub>3</sub>	F	F
II-11	B	CF <sub>3</sub>	H	Cl
II-12	B	CF <sub>3</sub>	H	F
II-13	B	CF <sub>3</sub>	CH <sub>3</sub>	Cl
25 II-14	B	CF <sub>3</sub>	CH <sub>3</sub>	F

Owing to their basic character, the compounds II are capable of forming salts or adducts with inorganic or organic acids or with metal ions.

30 Examples of inorganic acids are hydrohalic acids, such as hydrogen fluoride, hydrogen chloride, hydrogen bromide and hydrogen iodide, sulfuric acid, phosphoric acid, carbonic acid and nitric acid.

35 Suitable organic acids are, for example, formic acid, and alkanolic acids, such as acetic acid, trifluoroacetic acid, trichloroacetic acid and propionic acid, and also glycolic acid, thiocyanic acid, lactic acid, succinic acid, citric acid, benzoic acid, cinnamic acid, oxalic acid, alkylsulfonic acids (sulfonic acids having straight-chain or branched alkyl radicals with 1 to 20 carbon atoms), arylsulfonic acids or aryldisulfonic acids (aromatic radicals, such as phenyl and naphthyl, which carry one or two sulfo groups), alkylphosphonic acids (phosphonic acids  
40 having straight-chain or branched alkyl radicals with 1 to 20 carbon atoms), arylphosphonic acids or aryldiphosphonic acids (aromatic radicals, such as phenyl and naphthyl, which carry one  
45

## 5

or two phosphonic acid radicals), it being possible for the alkyl or aryl radicals to carry further substituents, for example p-toluenesulfonic acid, salicylic acid, p-aminosalicylic acid, 2-phenoxybenzoic acid, 2-acetoxybenzoic acid, etc.

5

Suitable metal ions are, in particular, the ions of the elements of the second main group, in particular calcium and magnesium, of the third and fourth main groups, in particular aluminum, tin and lead, and of the first to eighth transition groups, in particular  
10 chromium, manganese, iron, cobalt, nickel, copper and zinc and others. Particular preference is given to the metal ions of the elements of the transition groups of the fourth period. The metals can be present in the various valences which they can assume.

15

When preparing the mixtures, it is preferred to employ the pure active compounds I and II, with which further active compounds against harmful fungi or other pests, such as insects, arachnids or nematodes, or else herbicidal or growth-regulating active  
20 compounds or fertilizers can be admixed as required.

The mixtures of the compounds I and II, or the simultaneous joint or separate use of the compounds I and II, have outstanding action against a wide range of phytopathogenic fungi, in  
25 particular from the classes of the *Ascomycetes*, *Deuteromycetes*, *Oomycetes* and *Basidiomycetes*. Some of them act systemically and are therefore also suitable for use as foliar- and soil-acting fungicides.

30 They are especially important for controlling a large number of fungi in a variety of crop plants, such as cotton, vegetable species (for example cucumbers, beans and cucurbits), barley, grass, oats, coffee, corn, fruit species, rice, rye, soya, grapevine, wheat, ornamentals, sugarcane, and a variety of seeds.

35

They are particularly suitable for controlling the following phytopathogenic fungi: *Erysiphe cichoracearum* and *Sphaerotheca fuliginea* in cucurbits, *Podosphaera leucotricha* in apples, *Uncinula necator* in grapevines, *Puccinia* species in cereals,  
40 *Rhizoctonia* species in cotton, rice and lawns, *Ustilago* species in cereals and sugarcane, *Venturia inaequalis* (scab) in apples, *Helminthosporium* species in cereals, *Septoria nodorum* in wheat, *Botrytis cinerea* (gray mold) in strawberries, vegetables, ornamentals and grapevines, *Cercospora arachidicola* in  
45 groundnuts, *Pseudocercospora herpotrichoides* in wheat and barley, *Pyricularia oryzae* in rice, *Phytophthora infestans* in potatoes and tomatoes, *Pseudoperonospora* species in cucurbits and

hops, *Plasmopara viticola* in grapevines, *Alternaria* species in vegetables and fruit and *Fusarium* and *Verticillium* species.

Furthermore, they can be used in the protection of materials (for example the protection of wood), for example against *Paecilomyces variotii*.

The compounds I and II can be applied simultaneously, that is either together or separately, or in succession, the sequence, in the case of separate application, generally not having any effect on the control results.

The compounds I and II are usually applied in a weight ratio of from 100:1 to 1:50, preferably from 50:1 to 1:50, in particular from 10:1 to 1:10.

Correspondingly, the application rates for the compound I are usually from 5 to 2 000 g/ha, preferably from 10 to 1 000 g/ha, in particular from 50 to 750 g/ha.

Depending on the nature of the desired effect, the application rates of the mixtures according to the invention are, for the compounds II, from 5 g/ha to 500 g/ha, preferably from 50 to 500 g/ha, in particular from 50 to 200 g/ha.

For seed treatment, the application rates of the mixture are generally from 0.001 to 1 g/kg of seed, preferably from 0.01 to 0.5 g/kg, in particular from 0.01 to 0.1 g/kg.

If phytopathogenic harmful fungi are to be controlled, the separate or joint application of the compounds I and II or of the mixtures of the compounds I and II is effected by spraying or dusting the seeds, the plants or the soils before or after sowing, or before or after plant emergence.

The fungicidal synergistic mixtures according to the invention, or the compounds I and II, can be formulated, for example, in the form of ready-to-spray solutions, powders and suspensions or in the form of highly concentrated aqueous, oily or other suspensions, dispersions, emulsions, oil dispersions, pastes, dusts, materials for broadcasting or granules, and applied by spraying, atomizing, dusting, broadcasting or watering. The use form depends on the intended purpose; in each case, it should ensure as fine and uniform a distribution as possible of the mixture according to the invention.

The formulations are prepared in a manner known per se, for example by adding solvents and/or carriers. It is usual to admix inert additives, such as emulsifiers or dispersants, with the formulations.

- 5 Suitable surfactants are the alkali metal salts, alkaline earth metal salts and ammonium salts of aromatic sulfonic acids, for example ligno-, phenol-, naphthalene- and dibutylnaphthalenesulfonic acids, and of fatty acids, alkyl- and alkylarylsulfonates, alkyl, lauryl ether and fatty alcohol
- 10 sulfates, and salts of sulfated hexa-, hepta- and octadecanols, or of fatty alcohol glycol ethers, condensates of sulfonated naphthalene and its derivatives with formaldehyde, condensates of naphthalene or of the naphthalenesulfonic acids with phenol and formaldehyde, polyoxyethylene octylphenyl ether, ethoxylated
- 15 isooctyl-, octyl- or nonylphenol, alkylphenyl polyglycol ethers, tributylphenyl polyglycol ethers, alkylaryl polyether alcohols, isotridecyl alcohol, fatty alcohol/ethylene oxide condensates, ethoxylated castor oil, polyoxyethylene alkyl ethers or polyoxypropylene alkyl ethers, lauryl alcohol polyglycol ether
- 20 acetate, sorbitol esters, lignosulfite waste liquors or methyl cellulose.

- Powders, materials for broadcasting and dusts can be prepared by mixing or jointly grinding the compounds I and II or the mixture
- 25 of the compounds I and II with a solid carrier.

- Granules (for example coated granules, impregnated granules or homogeneous granules) are usually prepared by binding the active compound, or active compounds, to a solid carrier.

- 30 Fillers or solid carriers are, for example, mineral earths, such as silica gel, silicic acids, silicates, talc, kaolin, limestone, lime, chalk, bole, loess, clay, dolomite, diatomaceous earth, calcium sulfate, magnesium sulfate, magnesium oxide, ground
- 35 synthetic materials, and fertilizers, such as ammonium sulfate, ammonium phosphate, ammonium nitrate, ureas and products of vegetable origin, such as cereal meal, tree bark meal, wood meal and nutshell meal, cellulose powders or other solid carriers.

- 40 The formulations generally comprise from 0.1 to 95% by weight, preferably from 0.5 to 90% by weight, of one of the compounds I and II or of the mixture of the compounds I and II. The active compounds are employed in a purity of from 90% to 100%, preferably from 95% to 100% (according to NMR spectrum or HPLC).

## 8

The compounds I and II, the mixtures or the corresponding formulations are applied by treating the harmful fungi, or the plants, seeds, soils, areas, materials or spaces to be kept free from them with a fungicidally effective amount of the mixture, or  
5 of the compounds I and II in the case of separate application. Application can be effected before or after infection by the harmful fungi.

Examples of such preparations comprising the active compounds  
10 are:

- I. A solution of 90 parts by weight of the active compounds and 10 parts by weight of N-methylpyrrolidone; this solution is suitable for use in the form of microdrops;
- 15 II. A mixture of 20 parts by weight of the active compounds, 80 parts by weight of xylene, 10 parts by weight of the adduct of 8 to 10 mol of ethylene oxide and 1 mol of oleic acid N-monoethanolamide, 5 parts by weight of the calcium salt of dodecylbenzenesulfonate, 5 parts by weight of the adduct of  
20 40 mol of ethylene oxide and 1 mol of castor oil; a dispersion is obtained by finely distributing the solution in water;
- III. An aqueous dispersion of 20 parts by weight of the active ingredients, 40 parts by weight of cyclohexanone, 30 parts by  
25 weight of isobutanol, 20 parts by weight of the adduct of 40 mol of ethylene oxide and 1 mol of castor oil;
- IV. An aqueous dispersion of 20 parts by weight of the active ingredients, 25 parts by weight of cyclohexanol, 65 parts by weight of a mineral oil fraction of boiling point 210 to  
30 280°C, and 10 parts by weight of the adduct of 40 mol of ethylene oxide and 1 mol of castor oil;
- V. A mixture, ground in a hammer mill, of 80 parts by weight of the active compounds, 3 parts by weight of the sodium salt of diisobutyl-naphthalene-1-sulfonic acid, 10 parts by weight of  
35 the sodium salt of a lignosulfonic acid from a sulfite waste liquor and 7 parts by weight of pulverulent silica gel; a spray mixture is obtained by finely distributing the mixture in water;
- VI. An intimate mixture of 3 parts by weight of the active  
40 ingredients and 97 parts by weight of finely divided kaolin; this dust comprises 3% by weight of active compound;
- VII. An intimate mixture of 30 parts by weight of the active ingredients, 92 parts by weight of pulverulent silica gel and  
45 8 parts by weight of paraffin oil which had been sprayed onto the surface of this silica gel; this formulation imparts good adhesion to the active compound;



- VIII.A stable aqueous dispersion of 40 parts by weight of the active compounds, 10 parts by weight of the sodium salt of a phenolsulfonic acid/urea/formaldehyde condensate, 2 parts by weight of silica gel and 48 parts by weight of water; this dispersion may be diluted further;
- IX. A stable oily dispersion of 20 parts by weight of the active compounds, 2 parts by weight of the calcium salt of dodecylbenzenesulfonic acid, 8 parts by weight of fatty alcohol polyglycol ether, 20 parts by weight of the sodium salt of a phenolsulfonic acid/urea/formaldehyde condensate and 88 parts by weight of a paraffinic mineral oil.

The fungicidal activity of the compound and of the mixtures can be demonstrated by the following experiments:

- The active compounds were prepared separately as a stock solution comprising 0.25% by weight of active compound in acetone or DMSO. 1% by weight of the emulsifier Uniperol® EL (wetting agent having emulsifying and dispersing action based on ethoxylated alkylphenols) was added to this solution, and the mixture was diluted with water to the desired concentration.

Use Example: Activity against early blight of tomato caused by *Alternaria solani*

- Leaves of potted plants of the cultivar "Große Fleischtomate St. Pierre" were sprayed to runoff point with an aqueous suspension having the concentration of active compounds stated below. The next day, the leaves were infected with an aqueous zoospore suspension of *Alternaria solani* in 2% biomalt solution having a density of  $0.17 \times 10^6$  spores/ml. The plants were then placed in a water-vapor-saturated chamber at temperatures of between 20 and 22 C. After 5 days, the infection on the leaves of the untreated, but infected control plants had developed to such an extent that the infection could be determined visually in %.

- Evaluation was carried out by determining the infected leaf area in per cent. These percentages were converted into efficacies.

The efficacy (E) is calculated as follows using Abbot's formula:

$$E = (1 - \alpha/\beta) \cdot 100$$

- $\alpha$  corresponds to the fungal infection of the treated plants in % and
- $\beta$  corresponds to the fungal infection of the untreated (control) plants in %

## 10

An efficacy of 0 means that the infection level of the treated plants corresponds to that of the untreated control plants; an efficacy of 100 means that the treated plants were not infected.

- 5 The expected efficacies of the active compound mixtures are determined using Colby's formula [S.R. Colby, Weeds 15, 20-22 (1967)] and compared with the observed efficacies.

Colby's formula:

10

$$E = x + y - x \cdot y / 100$$

- E expected efficacy, expressed in % of the untreated control, when using the mixture of the active compounds A and B at the concentrations a and b
- 15
- x efficacy, expressed in % of the untreated control, when using active compound A at a concentration of a
- 20 y efficacy, expressed in % of the untreated control, when using active compound B at a concentration of b

Table A - Individual active compounds

25	Example	Active compound	Concentration of active compound in the spray liquor [ppm]	Efficacy in % of the untreated control
	1	control (untreated)	(82 % infection)	0
30	2	I (dithianon)	63 31 16 8	63 27 0 0
35	3	II-1 (boscalid)	63 31 16 8	88 82 76 63
40	4	II-2	63 31 16 8	88 27 39 27

45

Table B - Combinations according to the invention

Example	Active compound mixture Concentration Mixing ratio	Observed efficacy	Calculated efficacy*)
5	I + II-1 63 + 8 ppm 8 : 1	100	87
6	I + II-1 31 + 31 ppm 1 : 1	100	87
7	I + II-1 16 + 16 ppm 1 : 1	100	76
8	I + II-1 8 + 8 ppm 1 : 1	100	63
9	I + II-1 8 + 63 ppm 1 : 8	99	88
10	I + II-2 63 + 8 ppm 8 : 1	100	73
11	I + II-2 31 + 31 ppm 1 : 1	99	46
12	I + II-2 16 + 16 ppm 1 : 1	99	39
13	I + II-2 8 + 8 ppm 1 : 1	100	27
14	I + II-2 8 + 63 ppm 1 : 8	100	88

\*) efficacy calculated using Colby's formula

The test results show that, for all mixing ratios, the observed efficacy is higher than the efficacy predicted using Colby's formula.